

Remarks

Thorough examination by the Examiner is noted and appreciated.

In response to a telephone conversation November 23, 2004 with Examiner, the present Supplemental amendment is submitted to eliminate the basis of a 35 USC 112, section 1 rejection and place the claims in condition for allowance.

Applicants respectfully request reconsideration of Examiners rejections.

Claim Rejections under 35 USC 112

1. Claims 1-9 are rejected under 35 USC 112, first paragraph as containing subject matter which was not described in the Specification in such a way as to reasonably convey to one skilled in the art that the inventors at the time of the application was filed, has possession of the claimed invention.

Applicants have amended claims 1 and 10 to clarify that the method is for preventing photo-induced chemical attack on copper during a copper oxide removal process as suggested by Examiner in a Telephone conversation on November 23, 2004.

Claim Rejections under 35 USC 103

2. Claims 1-12, 14, and 16-21 stand rejected under 35 USC 103(a) as being unpatentable over by Edelstein et al. (US 6,251,787 or 6,153,043), in view of Chang et al (US 6,323,131), Zhang et al. (6,162,301), and Kneer (US 6,147,002).

Note that column and line number citations are with respect to Edelstein et al. '787, though similar or the same disclosure is found in '043.

Edelstein et al. disclose and teach **eliminating exposure of PN junctions to light** capable of invoking a **photovoltaic reaction** to prevent electrochemical dissolution of metal components in contact with an electrolyte (see Abstract; col 5, lines 25-34).

Edelstein et al. further teach that PN junctions are formed by introducing impurity atoms into areas of a semiconductor wafer (col 5, lines 10-13) and further teaches that exposure of the PN junctions to light of certain wavelengths essentially acts as a battery supplying current to metal interconnects (col 5, lines 29-34) which, when **in contact with an electrolyte** can lead to electrochemical dissolution of the metal. Edelstein teaches eliminating exposure of **semiconductor PN junctions** to light

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having wavelengths less than about 1.1 micron for **silicon wafers** and 0.9 microns for **GaAs wafers** (col 5, lines 52-59).

Edelstein et al., therefore generally teaches generally teaches eliminating exposure of **semiconductor PN junctions** rather than copper interconnects having an overlying copper oxide layer in a copper oxide removal process. Moreover, Edelstein et al. do not recognize or appreciate the required acidity (pH) of an acidic copper oxide removing (cleaning) solution or the photo-induced chemical attack that occurs in such circumstances, which Applicants have shown is an unexpected effect by presentation of experimental results in the Specification. Edelstein et al. simply does not recognize the unexpected effect of an acidic copper oxide removing solution on a copper oxide layer overlying a copper interconnect while being exposed to specific wavelengths of light. For example, the wave lengths of light disclosed and claimed by Applicants would likely not penetrate through a dielectric layer or a backside of a semiconductor substrate (e.g., 300 nm - 800 nm) to impact a PN junction as disclosed in the method of Edelstein et al.

Thus, the principal of operation of the method and teachings of Edelstein et al. is different in operation and effect than the

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method and principal of operation of Applicants disclosed and claimed invention. For example, in the method of Edelstein et al., PN junctions are required to be illuminated, which would require light to penetrate to the PN junctions, thereby causing **copper** corrosion where the copper is in contact with the electrolyte. Edelstein et al. do not teach or disclose the effect of an overlying copper oxide layer or an acidic solution in contact with the copper oxide layer. Edelstein teaches contact of an electrolyte with **copper**, and does not recognize a specific pH requirement.

Nowhere do Edelstein et al. disclose or teach "shielding the exposed copper **oxide** containing surface to substantially block incident light from impacting the exposed copper oxide containing surface while contacting the exposed copper oxide containing surface with the acidic cleaning solution".

Nowhere do Edelstein et al. disclose or recognize a photo-induced chemical attack on copper in the presence of an overlying copper oxide layer during a copper oxide removal process. The teachings of Edelstein et al. do not discuss the presence of copper oxide, or discuss or suggest that exposure of copper oxide overlying a copper surface at the specified pH levels as shown by Applicants can lead to copper corrosion. Applicants do not

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disclose or claim a photovoltaic effect involving a PN junction as Edelstein et al. contemplate. Rather, the teachings of Edelstein suggest that a photochemical induced photovoltaic reaction with **copper** would likely be prevented by an overlying copper oxide layer. Moreover, copper interconnects in the method of Applicants need not be in contact with a PN junction as is required in the method of Edelstein et al.

The disclosure of Applicant, as the experimental section makes clear, is a method for preventing **photo-induced chemical attack** on copper during a copper oxide removal process at the relevant pH's disclosed. Applicants have discovered an unexpected result in a particular pH range during a copper oxide removal process. Nowhere do Edelstein et al. disclose or recognize such a process.

Applicants do not disclose or teach that illumination of a PN junction and associated photo-voltaic induced electrolysis as the principal of operation. Rather, Applicants make clear in the Specification by the presentation of experimental results relating to light exposure of a copper electrode with a **copper oxide containing surface in contact with an acidic solution within a particular pH range.**

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"A prior art reference must be considered in its entirety, i.e., as a whole including portions that would lead away from the claimed invention." *W.L. Gore & Associates, Inc., Garlock, Inc.*, 721 F.2d, 1540, 220 USPQ 303 (Fed Cir. 1983), cert denied, 469 U.S. 851 (1984).

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious." *In re Ratti*, 270 F.2d 810, 123, USPQ 349 (CCPA 1959).

With respect to claims 1 and 10 Edelstein et al. neither disclose the claimed wavelength ranges of Applicants nor the pH ranges that Applicants disclose and claim.

Applicants note that Examiner admits that Edelstein et al. do not teach or disclose an acidic cleaning solution including Applicants claimed pH ranges.

Obeng et al. teach "a ULSI circuit chip comprising copper interconnects with a corrosion protection layer of the surface of the copper which layer is comprised of a self assembled organic monolayer" to prevent corrosion of the copper during CMP and post

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CMP cleaning conditions (see col 3, lines 60-64). Obeng et al teach a post CMP cleaning process with CO₂ sparged deionized water having a pH of about 4.

There is no apparent motive for combining Obeng et al. with Edelstein et al., other than Applicants disclosure. For example, Obeng et al. do not disclose or suggest a photo-voltaic induced erosion of copper in contact with a PN junction as disclosed in Edelstein et al. or photo-induced chemical attack of copper in the presence of copper oxide during a copper oxide removal process as Applicants have disclosed and claimed. The fact that acidic cleaning solutions are known in the prior art does not help Examiner in making out a *prima facie* case of obviousness with respect Applicants disclosed and claimed invention.

Applicants, in discussing the prior art and the problem presented in the prior art (see paragraph 009), note that an acidic cleaning solution from removing copper oxide **can accelerate** the erosion of copper, a problem that Applicants disclosed and claimed invention solves. Thus, the combination of Obeng et al. with Edelstein et al. does nothing to help Examiner in establishing a *prima facie* case of obviousness.

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Zhang et al. also teach an acidic cleaning solution for cleaning a wafer surface post-CMP following polishing a copper layer (see Abstract).

The same comments made above with respect to Obeng et al., apply to Zhang et al. There is no apparent motive for combination with Edelstein et al. except for Applicants disclosure. There is no teaching or suggestion in Zhang et al. that a post CMP cleaning process with an acidic cleaning solution may be related to a photovoltaic induced erosion of copper as taught by Edelstein et al. or a photo-induced chemical attack of copper during a copper oxide cleaning process as disclosed and claimed by Applicants. Even assuming *arguendo* proper motivation for combination, such combination fails to produce Applicants claimed invention or recognize or solve the problem that Applicants have recognized and solved by their disclosed and claimed invention.

With respect to Kneer et al., Applicants reiterate the above comments made with respect to Zhang et al. and Obeng et al.. Kneer et al., also disclose an acidic cleaning solution for cleaning copper following CMP planarization. Moreover, Kneer et al. teaches a cleaning solution that **slightly etches the copper** (see col 4, lines 54 - 65), taught to be desirable to remove

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contaminants. There is no recognition or discussion in Kneer et al. that an acidic cleaning solution may be related to a photovoltaic induced erosion of copper as taught by Edelstein et al., or a photo-induced chemical attack of copper in the presence of copper oxide during copper oxide removal as disclosed and claimed by Applicants. Kneer et al. in combination with Edelstein et al., do not recognize the problem or provide a solution to the problem Applicants have recognized and solved by their disclosed and claimed invention;

"A method for preventing photo-induced chemical attack on a copper interconnect during removal of an overlying copper oxide containing surface"

Nevertheless, even assuming *arguendo* proper motivation for combining the references of Obeng et al., Zhang et al., Kneer et al., the references singly or in any combination fail to produce Applicants claimed invention or recognize or solve the problem that Applicants have recognized and solved by their disclosed and claimed invention.

"First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the

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reference or to combine reference teachings. Second, there must be a reasonable expectation of success. **Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure."** *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

When applying 35 U.S.C. 103, the following tenets of patent law must be adhered to:

- (A) **The claimed invention must be considered as a whole;**
- (B) **The references must be considered as a whole and must suggest the desirability and thus the obviousness of making the combination;**
- (C) **The references must be viewed without the benefit of impermissible hindsight vision afforded by the claimed invention; and**
- (D) **Reasonable expectation of success is the standard with which obviousness is determined.**

Hodosh v. Block Drug Co., Inc., 786 F.2d 1136, 1143 n.5, 229 USPQ 182, 187 n.5 (Fed. Cir. 1986).

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Applicants point out that "we do not pick and choose among the individual elements of assorted prior art references to recreate the claimed invention, but rather we look for some teaching or suggestion in the references to support their use in a particular claimed combination" *Symbol Technologies, Inc. v. Opticon, Inc.*, 935 F.2d 1569, 19 USPQ2d 1241 (Fed. Cir. 1991).

"The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990)

"[A] patentable invention may lie in the discovery of the source of a problem even though the remedy may be obvious once the source of the problem is identified. This is part of the 'subject matter as a whole' which should always be considered in determining the obviousness of an invention under 35 U.S.C. § 103." *In re Sponnoble*, 405 F.2d 578, 585, 160 USPQ 237, 243 (CCPA 1969).

The claims have been amended to clarify Applicants invention. A favorable reconsideration of Applicants' claims is respectfully requested.

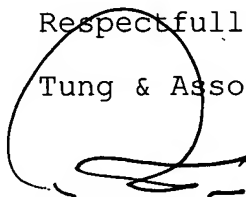
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Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

Tung & Associates

A handwritten signature in black ink, appearing to read 'Randy W. Tung', is written over a horizontal line. The signature is enclosed within a hand-drawn circle.

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